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Remarks

The present invention relates to a method of removing polymer generated in a semiconductor manufacturing process. The semiconductor manufacturing process may include sequentially depositing a lower metal layer, an insulating layer and an upper metal layer on a semiconductor substrate, forming a photoresist pattern on the upper metal layer, and etching the upper metal layer and the insulating layer using the photoresist pattern as a mask. The polymer may be generated during the etching step of the semiconductor manufacturing process. The method of removing polymer (as set forth in Claim 1 above) generally comprises:

(a) removing the photoresist pattern using an O_2/N_2 plasma; and

(b) removing the polymer existing on the lower metal layer using an H_2O/CF_4 plasma; and

(c) using a plasma from a gas consisting essentially of O_2, removing residues of the remaining photoresist pattern.

Independent Claim 8 contains similar limitations.

Alternatively, the present invention relates to a method of removing polymer (as set forth in Claim 10 above) that generally comprises:

(i) removing the first photoresist pattern by ashing with a first plasma from a first gas mixture consisting essentially of O_2 and N_2;

(ii) removing the polymer on the lower metal layer by ashing with a second plasma from a second gas mixture consisting essentially of H_2O and CF_4; and

(iii) removing remaining residues of the first photoresist pattern with a third plasma from a gas consisting essentially of O_2.

The reference cited against the claims (Jung, U.S. Pat. Appl. Publ. No. 2003/0114010 [hereinafter "Jung"]) is believed to neither disclose nor suggest removing a photoresist pattern by using a plasma of O_2 and N_2, removing a polymer from a lower metal layer by using a plasma of H_2O and CF_4, or removing residues of the remaining photoresist pattern using a plasma from a gas consisting essentially of O_2 (see Claims 1 and 8 above). Furthermore, the cited reference

neither discloses nor suggests removing a photoresist pattern by ashing with a first plasma from a first gas mixture consisting essentially of O_2 and N_2, removing a polymer on a lower metal layer by ashing with a second plasma from a second gas mixture consisting essentially of H_2O and CF_4, and removing residues of the remaining photoresist pattern with a third plasma from a gas consisting essentially of O_2 (see Claim 10 above). Consequently, the present claims are patentable over the cited reference.

The Rejection of Claims 1-3, 5-8, 10-12 and 14-19 under 35 U.S.C. § 103(a)

The rejection of Claims 1-3, 5-8, 10-12 and 14-19 under 35 U.S.C. § 103(a) as being unpatentable over the "Background" disclosure in the present application (hereinafter, "Applicant's discussion of the background") in view of Jung is respectfully traversed.

As explained previously, the evidence relied upon in the Office Action for concluding that the present application contains admitted prior art identifies no statement "identifying the ***work of another*** as 'prior art'" (*see* M.P.E.P. § 2129), official notice has not been taken that Applicant's discussion of the background includes information commonly known in the art, nor has the Examiner relied on a self-executed Affidavit attesting to his personal knowledge of facts establishing such information as prior art available under 35 U.S.C. §102. All effective assertions of such official notice were previously traversed (*see* the amendment filed March 3, 2006).

However, assuming for the sake of argument that the technology described in Applicant's discussion of the background is available as prior art against the present claims, the background discussion in the present application neither discloses nor suggests removing a photoresist pattern using an O_2 / N_2 plasma, removing a polymer from a lower metal layer using an H_2O / CF_4 plasma, or removing residues of the remaining photoresist pattern using a plasma from a gas consisting essentially of O_2, as recited in Claims 1 and 8 (and claims dependent therefrom). Furthermore, Applicant's discussion of the background neither discloses nor suggests removing a photoresist pattern by ashing with a first plasma from a first gas mixture consisting essentially of

O_2 and N_2, removing a polymer on a lower metal layer by ashing with a second plasma from a second gas mixture consisting essentially of H_2O and CF_4, and removing residues of the remaining photoresist pattern with a third plasma from a gas consisting essentially of O_2 (see new Claim 10).

Jung discloses a method for fabricating a semiconductor device which includes methods of photoresist stripping and cleaning, which shows a favorable contact resistance by performing dry cleaning while stripping a photoresist and effectively removing the residue formed on contact holes (see paragraph [0013]). In a first step, the polymers on the sidewalls are removed in a mixed gas atmosphere of N_2, H_2, H_2O, CF_4 and O_2 by using RF power and microwave (see paragraphs [0019]-[0020] and [0047]). In a second step, Jung removes a photoresist in a mixed gas atmosphere of N_2, CF_4 and O_2 (see paragraphs [0021] and [0048]), and in a third step, the residue on the bottom of via holes is removed in a mixed gas atmosphere of N_2, H_2O, CF_4 and O_2 by using a microwave (see paragraphs [0022] and [0049]).

Using the gas mixtures disclosed by Jung to remove polymers and residue on the bottom of via holes is believed to cause hardening of the polymers, because of the presence of H_2O gas in the gas mixtures. It is believed that the residues of the photoresist pattern may be relatively easily hardened when such residues first contact or are first exposed to a plasma from H_2O gas. On the other hand, the methods of claims 1 and 8 remove the photoresist pattern using an O_2/N_2 plasma, remove a polymer on a lower metal layer with an H_2O / CF_4 plasma, then remove remaining photoresist pattern residues with a plasma from a gas consisting essentially of O_2. The method of claim 10 differs (at least in part) in that the photoresist pattern is removed using a plasma from a first gas mixture consisting essentially of O_2 and N_2, and the polymer on the lower metal layer is removed by ashing with a second plasma from a second gas mixture consisting essentially of H_2O and CF_4. The claimed processes are beneficial because the residues of the photoresist pattern are believed to not be easily hardened when using O_2 gas in the plasma, without first using a plasma containing H_2O. The improvement can be best seen with regard to the amount of residues remaining after the photoresist removal process.

The table below contains results of comparative photoresist removal processes. As shown in the table, using an O_2 plasma first in the photoresist removal process causes less residues than when using an H_2O plasma.

Condition	residues
Using O_2 plasma first	391.8
Using H_2O plasma first	401.5

Thus, Jung is saliently deficient with regard to the present Claims 1, 8 and 10. Furthermore, because Jung discloses use of a plasma formed from gases in addition to O_2 to remove residue on the bottom of via holes, Jung fails to cure the deficiencies of Applicant's discussion of the background with regard to the present Claims 1, 8 and 10.

As a result, the combination of Applicant's discussion of the background and Jung fails to disclose or suggest removing remaining residues of the photoresist pattern using a plasma from a gas consisting essentially of O_2, as recited in Claims 1 and 8 above, or removing a photoresist pattern by ashing with a first plasma from a first gas mixture consisting essentially of O_2 and N_2, removing a polymer on a lower metal layer by ashing with a second plasma from a second gas mixture consisting essentially of H_2O and CF_4, and removing residues of the remaining photoresist pattern using a plasma from a gas consisting essentially of O_2, as recited in Claim 10 above. Consequently, this ground of rejection is unsustainable, and should be withdrawn.

Conclusions

In view of the above amendments and remarks, all bases for objection and rejection are believed to be overcome, and the application is believed to be in condition for allowance. Early notice to that effect is earnestly requested.

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If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

Respectfully submitted,

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